

SUBMISSION INSTRUCTIONS NO. 12

GROUNDWATER MONITORING AND SAMPLING & ANALYSIS PLANS FOR EXISTING REGULATED SANITARY LANDFILLS

I. APPLICABILITY OF INSTRUCTIONS

These instructions apply to existing sanitary landfills for which monitoring of groundwater is required. Corrective action groundwater monitoring under 9 VAC 20-80-310 C 1 will be addressed in Submission Instruction (RESERVED). The instructions refer to requirements contained in the Virginia Solid Waste Management Regulations (VSWMR) promulgated by the Virginia Waste Management Board, effective December 18, 1988, as amended, and describe the information to be included in groundwater monitoring, and groundwater sampling and analysis plans. An example format for the plans may be found as Attachment 1 to these submission instructions. The information provided shall become part of Module X of the facility's Permit.

II. GROUNDWATER MONITORING PROGRAM

[§ 300.A.2 and §§ 520.A., § 250.C.14., 9 VAC 20-80-10]

The facility's groundwater monitoring program (GMP) shall be capable of determining the impact to groundwater quality of the uppermost aquifer that underlies the facility during the facility's active life and post-closure care period. The technical information submitted may also be made a part of the design plans and report or the facility's operation manual, but must be submitted as separate documents which can be incorporated into the facility's permit as Module X. At a minimum, the GMP shall address all the technical information specified in these instructions, and shall include a Site Plan drawing which identifies all physical aspects of the groundwater monitoring network.

The GMP shall be written and certified by a qualified groundwater scientist and shall contain a discussion of site geology and the characteristics of the uppermost aquifer. The groundwater sampling and analysis plan (GSAP) shall describe site procedures for sample collection, preservation, shipment, analysis, chain-of-custody, QA/QC, the statistical evaluation of the laboratory analytical results, and reporting procedures.

A. Site Location Information

Provide a copy of a portion of the USGS 7 ½ minute topographic map showing the location of the facility as a Figure in the GMP. Describe the site location, noting the county and municipality in which the landfill is located, use of adjoining properties, and the main access route to and from the facility.

B. Description of the Uppermost Aquifer

At a minimum, the GMP shall identify:

- The geologic and hydrogeologic setting (include copies of any published geologic maps which cover the site area as Figures in the GMP).
- Site soils as described in USDA Soil Conservation Service surveys and from on site borings.
- The uppermost aquifer as defined through on-site subsurface investigations.

- Any hydraulically interconnected underlying aquifers (i.e., all likely subsurface flowpaths for waste constituents that may leak from the facility).
- An analysis of topographic / geomorphic features that may influence groundwater flow.
- An interpretation of the vertical and horizontal components of groundwater flow.
- A description of the field methods used in the study.
- The supporting data (published information) used to produce the GMP appropriately cited and keyed to the reference section of the GMP.

In addition, include the following site-specific hydrologic data as Appendices to the GMP:

- A classification and description of the properties (hydraulic conductivity, porosity, texture, thickness, etc.) of all site hydrogeologic units (i.e., aquifers and any intervening saturated and unsaturated units).
- Groundwater data, including: (a) groundwater water table contour maps, (b) well or piezometer hydrographs.
- A summary of the groundwater monitoring information available to date.
- Include historical groundwater surface elevation measurements in a Table format.

C. Groundwater Monitoring Program Plan Sheet

The GMP plan sheet must show the surveyed location of all groundwater monitoring devices (wells piezometers) onsite in relation to the waste management unit boundary, phasing of cells, the facility boundary, and any surface water features including seeps and springs. The GMP plan sheet shall also include a graphical scale, north arrow, and site topography shown at an appropriate contour interval.

D. Design of the Groundwater Monitoring system

[§§ 300.A.3., 9 VAC 20-80-10]

The groundwater monitoring system described in the GMP must be capable of yielding groundwater samples representative of the uppermost aquifer. The methods used in identifying zones of potential contaminant migration shall be described. The design of the system shall address each of the requirements shown below.

1. General.

[§ 300.A.2, 9 VAC 20-80-10]

The GMP shall describe how the geotechnical information gained during the installation of existing site monitoring wells, supports the number of proposed upgradient and downgradient monitoring points. Table 1 of these submission instructions identifies some common factors that govern the determination of the total number of site monitoring wells installed.

2. Downgradient Wells.

[§ 300.A.3a(2), 300.A.3f(2), 9 VAC 20-80-10]

The GMP shall describe how the downgradient groundwater monitoring wells are located to detect releases from the waste management unit(s) in the shortest period of time.

a. Horizontal Placement.

The GMP shall describe how the selected horizontal placement of the monitoring wells intercepts any potential pathways for contaminant migration (i.e. zones with relatively high intrinsic hydraulic conductivity, fractured or faulted zones, solution channels, or other heterogeneous formations). State the maximum lateral horizontal distance between each downgradient monitoring well.

b. Vertical Placement of Screened Interval.

The GMP shall describe how the well screen interval selected provides immediate detection of a release to the uppermost aquifer. Illustrate that the upgradient and downgradient well screens intercept the same uppermost aquifer. When a single well cannot adequately intercept and monitor the vertical extent of a potential pathway of contaminant migration, a well cluster shall be used. Factors shown in Table 2 of these submission instructions may indicate whether wells clusters may be needed on site.

3. Upgradient Wells.

[§ 300.A.3a(1), 300.A.3f(2), 9 VAC 20-80-10]

Describe how the proposed upgradient (background) well(s) will be located to provide representative samples of groundwater unaffected by landfill constituents. The GMP shall note that the upgradient wells are screened in the same portion of the aquifer as that monitored by the downgradient wells.

At a minimum, the GMP shall provide answers for the following:

- Are the upgradient wells far enough away from the waste management unit boundary to prevent any effects from contamination related to the disposal areas such as mounding?
- Are enough upgradient wells installed and screened at proper depths to adequately account for possible spatial variability of the aquifer?

4. Special Conditions.

[§ 300.A.4e, 9 VAC 20-80-10]

At a minimum, the GMP shall describe whether any of the special conditions listed below exist on site. The GMP must note how the groundwater monitoring system will be designed to take into account any special conditions found present. If none of the conditions below exist at the site, the GMP must state this explicitly.

- Waste management units located above a mounded groundwater table.
- Waste management units located above aquifers with seasonally variable groundwater flow directions.
- Waste management units located close to an upgradient property boundary limiting access to install upgradient monitoring points.
- Waste management units located in areas where nearby surface water features or proximity to tidally influenced surface water bodies may influence groundwater levels or expected flow paths.
- Waste management units located near intermittently or continuously used groundwater production wells.
- Waste management units located in Karst (carbonate bedrock) or faulted areas where subsurface geologic features may modify expected groundwater flow paths.

5. Non-Upgradient Background Wells.

[§ 300.A.4e, 9 VAC 20-80-10]

For wells that are not located upgradient from the waste management unit, but are proposed for use as background monitoring points, the GMP must demonstrate that either:

- The hydrogeologic conditions do not allow an exact determination of upgradient well points;
- That sampling at other wells will provide background groundwater quality that is as representative or more representative than that provided by a hydrologically upgradient well;
- Or that there is insufficient upgradient area within which to install monitoring wells as a result of the facility boundary situations.

6. Monitoring Well Replacement.

[§ 300.A.3e]

The GMP shall indicate that any monitoring well which fails to perform as designed due to any of the reasons shown below, shall be replaced prior to the next regularly scheduled groundwater sampling event to ensure the entire groundwater monitoring system continues to meet requirements of the VSWMR:

- internal damage,
- external damage,
- a change in the elevation of the groundwater table, or
- as a result of phased development of waste cells

E. Geotechnical Investigation Techniques

1. Drilling Methods.

[§ 300.A.3d, 9 VAC 20-80-10]

The GMP shall indicate the drilling method used. Selection of the drilling method should be based on minimizing disturbance of subsurface materials and limiting the risk of cross-contaminating groundwater.

2. Equipment Decontamination.

The GMP shall indicate the equipment decontamination procedures used during monitoring well installation to prevent cross contamination of wells.

3. Description of Drilling Fluids.

Drilling fluid(s) used during boring installation shall be described. The GMP shall provide analyses of the drilling fluid(s) to ensure the drilling fluid(s) is contaminant free, as well as listing steps to be taken to prevent cross-contamination if drilling fluid(s) are used on site.

4. Soil and Rock Sampling Techniques.

Identify how soil samples and rock cores are obtained on site and describe the field or laboratory analysis to be conducted on the collected samples.

F. Monitoring Well Construction

1. Construction Materials.

[§ 300.A.3c, 9 VAC 20-80-10]

List well construction materials and identify how the chosen materials will allow the wells to operate throughout the active life and post-closure care period of the facility without prohibiting the ability to obtain representative samples of groundwater.

a. Casing and Screen Type.

[§ 300.A.3c, 9 VAC 20-80-10]

Describe how the well design will ensure that:

- The intake will allow sufficient groundwater flow for sampling,
- Will minimize the entry of formation materials into the well casing, and
- Will ensure sufficient structural integrity to prevent the collapse of the intake structure.

For wells completed in unconsolidated materials, the well intake should consist of a screen or slotted casing with openings sized to ensure that formational material is prevented from passing into the well during development. Screens shall not be field-slotted.

The GMP shall describe the construction materials chosen for the well casings and screened intervals. In making a selection, the designer must consider the following situations:

- Long term structural integrity (ability of the well to operate over the active life and post-closure care period of the facility).
- Well construction materials should be inert (not bias the collection and analysis of low concentrations of inorganic or organic constituents by reacting with groundwater samples).
- Well casings and screens must be structurally sound to withstand vigorous well development procedures.

b. Filter Pack.

The GMP shall describe the materials used to construct the filter pack and show that the materials are chemically inert, well rounded, dimensionally stable and of proper size in relation to the screen slot size and the natural aquifer matrix.

c. Grouting Procedure.

The GMP shall show that the materials used to seal the annular space will prevent the migration of contaminants to the sampling zones and prevent cross contamination between strata. Sealants should be chemically compatible with the potential leachate to ensure seal integrity.

d. Surface Completion and Protective Measures.

The GMP shall describe surface completion and protective measures used to prevent surface run-off from entering and infiltrating down the annulus of the well and to protect the well from accidental damage or vandalism.

2. Well Survey Methods.

The GMP shall describe the methods to be used during the horizontal and vertical surveying of well positions. Note that the wells must be surveyed with an accuracy of 0.01 feet (vertically) and 0.05 feet (horizontally) and that a reference point must be established somewhere on the well casing. The GMP shall note whether the well surveying was conducted by a licensed or otherwise certified land surveyor.

G. Well Development

The GMP shall describe the field methods used to restore the natural hydraulic conductivity of the formation after well construction is complete. To be effective, the method(s) used for well development should involve reversals or surges in flow to avoid bridging by particles. Post- development groundwater samples must be clay- and silt-free.

H. Well Abandonment

The GMP shall include an abandonment plan which describes the methodology for proper abandonment of test pits, temporary borings, and monitoring wells which are removed from service due to damage, change in groundwater elevations, or phased waste cell development.

I. Documentation

[§ 300.A.3d, 9 VAC 20-80-10]

The GMP should at a minimum document the field information listed in Table 3 of these submission instructions.

J. Certification

[§ 300.A.3f(3), 9 VAC 20-80-10]

A transmittal letter, certified by a qualified groundwater scientist, shall be submitted to the Director acknowledging that all monitoring well(s) have been installed on site in accordance with submitted plans, if applicable, or with guidelines established in *Solid Waste Disposal Facility Criteria – Technical Manual, USEPA, 1993*. The certification letter shall be provided within 14 days of well completion.

III. GROUNDWATER SAMPLING AND ANALYSIS PLAN

[§ 300.A.4., 9 VAC 20-80-10]

Owner operators of existing sanitary landfills that require groundwater monitoring are expected to develop a groundwater sampling and analysis plan (GSAP). The GSAP shall describe procedures and techniques for sample collection, preservation and shipment, analytical procedures, and chain-of-custody and quality control. The GSAP shall describe the procedures that will be used to evaluate the analytical results of the groundwater sampling during the Detection and Assessment monitoring programs. The GSAP shall also provide information on the actions to be taken if it is determined that landfill constituents may have entered the groundwater in statistically significant concentrations above background.

A. Sample Collection

[§ 300.A.4a(1), 9 VAC 20-80-10]

The GSAP shall describe sample collection procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality.

1. Static Water Level Elevations.

[§§ 300.A.4c, 9 VAC 20-80-10]

The GSAP shall describe the process of obtaining static water elevations on site. The GSAP shall note that groundwater elevations will be measured in each well during each groundwater sampling event. The measurements taken shall include depth to standing water, and total well depth, each to an accuracy of 0.01 foot.

2. Well Evacuation.

The GSAP should describe the method that will be used to remove the standing water in the well and filter pack prior to sampling. The GSAP shall describe the calculations used to determine well volume removed, equipment used in the purge process, the method of purge water storage and disposition, and a description of decontamination procedures to be followed.

3. Number of Samples.

[§§ 300.A.4f, 9 VAC 20-80-10]

The GSAP shall indicate the number, quantity, and the type of groundwater samples collected for the groundwater monitoring program during each sampling event. If the facility intends to show that the frequency of the sampling should be less than specified in the Regulations, the illustration must be included in a separate document submitted to the Director, noting the following information:

- Lithology of the aquifer and unsaturated zone;
- Hydraulic conductivity of the aquifer and unsaturated zone;
- Groundwater flow rates;
- Minimum distance between upgradient edge of the disposal unit and downgradient monitoring well screen; and
- Resource value of the aquifer.

4. Sampling Equipment.

The GSAP shall specify the equipment used to minimize sample agitation and reduce contact with atmosphere during sample transfer. When used properly, the following devices are acceptable:

- Gas-operated, fluorocarbon resin or stainless steel squeeze pump ("bladder pump") with adjustable flow control;
- Bailer (teflon, PVC, or stainless steel), provided it is equipped with double check valves and bottom emptying device; or a syringe bailer (teflon, PVC, or stainless steel).

5. Sampling Order.

The GSAP shall specify how to determine the order in which the monitoring wells will be sampled on site to take into account

- Prior levels of impact to groundwater and
- The order of volatilization of the groundwater sampling parameters.

6. Sampling Measurements

Temperature, pH, and specific conductance measurements should be made in the field before and after sample collection as a check on stability of the groundwater during the

sample period. Turbidity at each well, measured in NTU's, should be noted during the groundwater sampling procedure.

7. Decontamination & Calibration Procedures.

If dedicated equipment will not be used during groundwater sampling, the GSAP shall describe the methods that will be used in disassembly and decontamination between sampling events at individual wells. The GSAP should also describe the calibration methods used on any direct-read monitoring/sampling equipment.

B. Sample Preservation and Handling

[§ 300.A.4a(2), 9 VAC 20-80-10].

The GSAP shall address the sample preservation methods and the container types used on site.

1. Sample Containers.

The GSAP shall describe the sample container type and procedures used to ensure that containers are free of contaminants prior to use. Acceptable containers are listed in the most current version of *Test Methods for Evaluating Solid Wastes – Physical/Chemical Methods (SW-846 – USEPA)*.

2. Sample Preservation.

The GSAP shall list sample preservation methods that will be used to retard or reduce biological action, hydrolysis, and sorption effects.

C. Chain-of-Custody

[§ 300.A.4a(4), 9 VAC 20-80-10]

The GSAP shall describe the chain-of-custody program that will allow for the tracking of possession and handling of individual samples from the time of field collection through laboratory analysis. The chain-of-custody program shall include the following elements.

1. Sample Labels.

Sample labels affixed to the samples shall contain at least the following information:

- Sample identification number;
- Name of collector;
- Date and time of collection;
- Place of collection;
- Parameters to be analyzed for (if space permits);
- Internal temperature of shipping container at time sample was placed;
- Internal temperature of shipping container upon opening at laboratory; and
- Maximum and minimum temperature range that occurred during shipment.

2. Sample Seal.

When samples will leave the operator's immediate control, such as shipment to a laboratory by a common carrier, a seal shall be provided on the shipping container or individual sample bottles to ensure that the samples have not been disturbed during transportation.

3. Chain-of-Custody Record.

To establish the documentation necessary to track sample possession from time of collection, a chain-of-custody record should be filled out and should accompany every sample. The record should contain the following types of information:

- Sample number;
- Signature of collector;
- Date and time of collection;
- Identification of well;
- Sample type and number of containers;
- Parameters requested for analysis;
- Signature of person involved in the chain of possession;
- Inclusive dates of possession;
- Internal temperature of shipping container when samples were placed into it;
- Maximum temperature recorded during shipment;
- Minimum temperature recorded during shipment; and
- Internal temperature of shipping container upon opening in the laboratory.

D. Field Log Book

The GSAP shall note that, at a minimum, the information included in Table 4 of these submission instructions shall be noted in a field log book during each groundwater sampling event

E. Laboratory Analytical Procedures.

[§§ 300.A.4a(3), 9 VAC 20-80-10]

The GSAP shall note the analytical procedures to be used on the groundwater samples (selected from among those contained in *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846 – USEPA*). The GSAP shall identify, in table format, one analytical method for each specific groundwater parameter on the Table 5.1 list (which includes both Detection and Assessment monitoring constituents). Proper quality assurance and control protocols, method detection limits (MDLs), laboratory limits of detection (LODs), laboratory limits of quantitation (LOQs), and percent recovery specifications should be clearly identified in the GSAP. The method chosen must meet the most current USEPA performance standards under *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846 – USEPA*.

F. Quality Assurance and Quality Control (QA/QC)

[§§ 300.A.4a(5), and 300.4b, 9 VAC 20-80-10]

The GSAP shall explicitly describe the QA/QC program to be used in the field and laboratory. If commercial laboratories are used, the operator must ensure that the laboratory of choice is exercising a QA/QC program that meets or exceeds that noted in the most current version of *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods, SW-846 – USEPA*.

1. Field QA/QC Program.

The GSAP shall provide for the routine collection and analysis of trip and equipment blanks to verify that the sample collection and handling process has not affected the

quality of the samples. The GSAP shall also describe a program for ensuring proper calibration of field equipment (prior to field use and re-calibrated in the field before measuring each sample) and equipment decontamination and chain-of-custody procedures.

2. Laboratory QA/QC Program.

The GSAP shall describe the use of standards, laboratory blanks, duplicates, and spiked samples for calibration and identification of potential matrix interference problems.

G. Establishing Background Data

1. Data from Upgradient Wells

[§ 300.A.4d and 300.A.4e, 9 VAC 20-80-10]

The GSAP shall describe the site-specific actions required to establish background groundwater quality in hydraulically upgradient wells for each monitoring constituent required.

2. Data from Wells that are not Hydraulically Upgradient

[§ 300.A.4d and 300.A.4e, 9 VAC 20-80-10]

The GSAP shall describe the site-specific actions required to establish background groundwater quality in background wells for each monitoring constituent required. A determination is required based on 9 VAC 20-80-250 D 4 e in order to consider data from wells that are not located hydraulically upgradient.

H. Techniques for the Evaluation of Groundwater Quality Data

[§§ 300.A.4h, 9 VAC 20-80-10].

The GSAP shall describe the procedures the facility will follow to determine whether or not there has been a statistically significant increase (see *Data Analysis Guidelines for Solid Waste Facilities Operating in Virginia (2000) – as updated*) over background for any groundwater monitoring constituents in Table 5.1 or 5.5 as applicable. The GSAP shall include the instructions on handling and evaluation of groundwater analytical data. Prior to submitting the analytical data to the Department, the facility shall compile and interpret the results of the sampling program. The facility shall ensure that any verification sampling events are completed within the compliance period, and that the interpretation of the analytical results of such events is included in the data report submitted to the Department. The manual shall address the methods used to report and interpret data that are measured above or below a limit of detection (LOD) specified by the laboratory. These values shall never be eliminated from the evaluation and shall receive the appropriate statistical treatment as described in the Department's *Data Analysis Guidelines for Solid Waste Facilities Operating in Virginia (2000) – as updated*. The GSAP shall describe procedures to address the following as identified in the department's data analysis guidelines.

- Reporting of Low and Zero Values.
- Missing Data Values.
- Outliers.

In addition the following must be provided consistent with the description provided and applicable department data analysis guidelines:

1. Statistical Tests.

[§300.A.4g, 300.D, 9 VAC 20-80-10]

The GSAP shall specify the statistical method(s) selected by the facility from among those listed in §300.D of the VSWMR, to interpret the groundwater analytical results. The statistical method chosen must be shown to meet the performance standard in §300.D of the regulations for the applicable data set as explained in applicable guidance.

2. Verification Sampling.

The GSAP shall note whether the permittee plans to use a verification sampling strategy (collection of a pre-planned number of additional samples). The verification sample must be independent from the initial sample. In the 1 of “N” approach, the facility can take as many as “N” re-samples during the same compliance period as the initial sampling. The VSWMR do not allow a facility to disregard the statistical evaluation in situation when the facility is unable to collect a verification sample, as planned. If the facility plans on taking a verification sample, the groundwater must be sampled during the same compliance period as the initial event, and statistical tests must include the verification sample results prior to submitting the final results to the Department.

3. Records and Reports.

[§ 300.E, 9 VAC 20-80-10]

The GSAP shall describe the data types that will be kept, the format in which they will be recorded, and the format and submission timelines of any required reports dealing with the results of groundwater sampling.

I. Statistical Analysis of Subsequent Well Data

1. Comparison with Subsequent Well Data.

[§ 300.A.D.4h, §§ 300.D.5c(3) and 300.D, and 9 VAC 20-80-10]

The GSAP shall specify actions that the operator will undertake to determine whether or not a statistically significant increase over background values for each constituent has occurred at the close of each sampling event.

2. Required Response Actions.

The GSAP shall describe the facility's responses, under the allowed reporting time frames, for any statistically significant increases noted in one or more groundwater monitoring constituents.

J. Groundwater Elevation Data Interpretation

[§ 300.A.4c, 9 VAC 20-80-10]

The facility shall determine the rate and flow direction each time groundwater is sampled. The GSAP must describe the actions required to be taken on site if one or more of the monitoring wells is determined to no longer function as designed due to a change in the groundwater flow direction. The actions must be completed prior to the next regularly

scheduled groundwater sampling event to fulfill the regulatory requirements of the groundwater monitoring system.

K. Recordkeeping and Reporting

[§ 300.E, 9 VAC 20-80-10]

The GSAP must describe the recordkeeping and reporting procedures including where, and for how long, facility records will be retained; and by what date an annual groundwater monitoring report shall be submitted to the Director.

IV. REFERENCES

Both the GMP and the GSAP shall contain a full listing of any published scientific research used during the development of the both documents. The formatting of the References section shall follow that utilized by the Geological Society of America (i.e., Author's Name, Publication Date, Publication Title, Publication Source, Volume, Page Number).

V. APPENDICES

Both the GMP and the GSAP shall contain Appendices that shall include information such as, but not limited too, boring logs, groundwater flow calculations, aquifer properties data sheets, field notes, which can not be easily summarized as text in the main documents. The numbering and order of the Appendices will be up to the Permittee.

TABLE 1
FACTORS INFLUENCING THE INTERVALS BETWEEN
INDIVIDUAL MONITORING WELLS

<i>Intervals between wells should be closer if:</i>	<i>Intervals between wells may be wider if:</i>
<p><u>Site has factors such as:</u></p> <ul style="list-style-type: none"> • Liquid waste is managed on-site • Site is very small in size • Permeable fill material is located near the waste management unit (where preferential flow may occur) • There are buried pipes, utility trenches, etc., where point-source leak might occur <p><u>Site has complicated geology:</u></p> <ul style="list-style-type: none"> • Closely spaced bedrock fractures • Faults zones • Tight folds • Karst (solution channels) • Discontinuous structures <p><u>Site has complicated hydrogeology:</u></p> <ul style="list-style-type: none"> • Variable hydraulic conductivity • Variable lithology • Site is in or near a recharge zone • Site has steep or variable hydraulic gradient • Site is characterized by a low dispersivity potential • Site has a high seepage velocity 	<ul style="list-style-type: none"> • The Department recommends that the linear distance between wells not exceed 500 feet unless it can be shown that one or more of the factors show below exist onsite. <p><u>Site has simple geology:</u></p> <ul style="list-style-type: none"> • No fracture zones • No fault zones • No folded rocks • No Karst (solution channels) • No discontinuous structures <p><u>Site has homogeneous conditions:</u></p> <ul style="list-style-type: none"> • Uniform hydraulic conductivity • Uniform lithology • Site has a low (flat) and constant hydraulic gradient • Site is characterized by a high dispersivity potential • Site has a low seepage velocity

TABLE 2
FACTORS AFFECTING NUMBER OF WELL POINTS PER MONITORING LOCATION

One Well Point Per Sampling Location May Be OK If There Are:

- No "sinkers" or "floaters" (immiscible liquid phases) expected in the groundwater
- Thin flow zone relative to monitoring well screen length
- Data indicating a homogeneous uppermost aquifer (i.e., simple aquifer geology)

More than One Well Point Per Sampling Location Needed If:

- Presence of immiscible liquids found in the groundwater
- Data indicates a heterogeneous uppermost aquifer (i.e., complicated aquifer geology)
- Site has multiple, interconnected aquifers
 - Site has perched water-bearing zones
 - Groundwater is contained in discrete bedrock fracture zones

TABLE 3
**INFORMATION TO BE RECORDED DURING MONITORING WELL
 INSTALLATION**

- | | |
|--|--|
| <ul style="list-style-type: none"> • Date/time of construction • Drilling method and drilling fluid used • Bore hole and well casing diameter • Casing materials • Screen materials and design • Casing and screen joint type • Screen size/length • Filter pack material, size, and grain analysis (D10) • Filter pack volume calculations • Filter pack placement method • Sealant materials (percent bentonite) • Sealant volume (pounds per gallon of cement) • Sealant placement method • Surface seal design and construction • Well development procedure • Type of protective well cap • “As built” well diagram including dimensions | <ul style="list-style-type: none"> • Well location, specified to within 0.5 foot in horizontal plane • Well depth, specified to within 0.01 foot • Ground surface elevation, specified to within 0.01 foot • Surveyor's pin elevation on concrete apron, specified to within 0.01 foot • Top of monitoring well casing elevation, specified to within 0.01 foot • Top of protective steel casing elevation, specified to within 0.001 foot • Drilling and lithologic logs |
|--|--|

TABLE 4
INFORMATION TO BE RECORDED DURING GROUNDWATER SAMPLING OF
EACH COMPLIANCE MONITORING WELL

- | | |
|--|---|
| • Well identification number | • Well location, specified to within 0.5 foot in horizontal plane |
| • Well depth | • Name of collector |
| • Static water level depth and measurement technique | • Date and time of sample collection |
| • Presence of immiscible layers (yes – no) | • Sampling procedure |
| • Estimated Well yield | • Sampling equipment |
| • Purge volume and purge pumping rate | • Types of sample containers used and sample identification numbers |
| • Exact time well purge began and ended | • Preservative used |
| • Well evacuation procedure and equipment | • Sample destination and transporter |
| • Field analysis data and methods | • Internal temperature of field and shipping containers |
| • Climatic conditions including air temperature | |
| • Field observations on sampling event | |

TABLE 5
ALPHA VALUE MODIFICATIONS FOR USE IN VERIFICATION SAMPLING
STRATEGIES

- a) Select a default value for $\alpha = 0.01$
 $\alpha = 0.01$
- b) Pass the first or one of one verification re-samples, adjust alpha
 $\alpha = (1 - .95^{\frac{1}{k}})^{\frac{1}{2}}$
- c) Pass the first or one of two verification re-samples, adjust alpha
 $\alpha = (1 - .95^{\frac{1}{k}})^{\frac{1}{3}}$
- d) Pass the first or two of two verification re-samples, adjust alpha
 $\alpha = \sqrt{1 - 0.95^{\frac{1}{k}}} \sqrt{\frac{1}{2}}$

Where k is the number of comparisons and α is the site-wide false positive rate. Please note that alpha can not be less than 0.01 unless the facility shows that the statistical comparison has at least as much statistical power as published EPA reference power curves.

Attachment 1
Groundwater Monitoring and Sampling & Analysis Plan
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B – Sample Preservation and Handling

- 1 – Sample Containers
- 2 – Sample Preservation

C – Chain of Custody

- 1 – Sample Labels
- 2 – Sample Seals
- 3 – Chain of Custody Record

D - Field Log Book

E – Laboratory Analytical Procedures

F – Quality Assurance and Quality Control

- 1 – Field QA/QC Program
- 2 – Laboratory QA/QC Program

G – Establishing Background Data

- 1 – Background Data from Downgradient Wells
- 2 – Background Data from Upgradient Wells

H – Techniques for the Evaluation of Groundwater Quality Data

- 1 – Reporting Low and Zero Values
- 2 – Missing Data Values
- 3 – Outliers
- 4 – Statistical Tests
- 5 – Verification Sampling
- 6 – Records and Reports

I – Statistical Analysis of Subsequent Well Data

- 1 – Comparison with Subsequent Well Data
- 2 – Required Response Actions

J – Groundwater Elevation Data Interpretation

K – Record Keeping and Reporting

IV – REFERENCES

V - APPENDICES